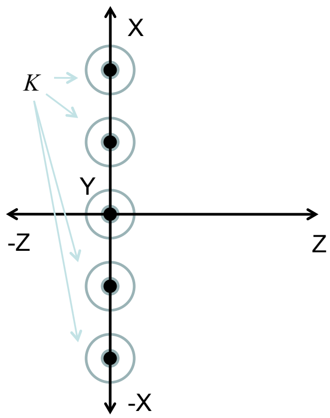
r1

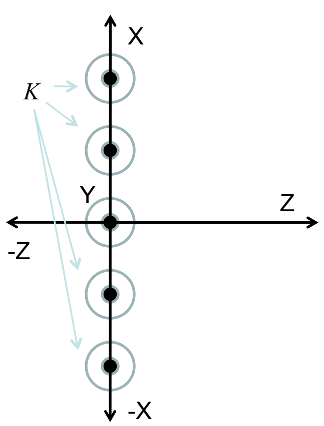
A neutral, infinite current sheet, **K**, flows in the *x*-*y* plane, in the +*y* direction. To the right of the *x*-*y* plane, according to what you know from Phys 3310, the **E** and **B** field directions are:



A) **E** along *z*-axis, **B** is zero
B) **B** along *z*-axis, **E** is zero
C) **B** along *y*, **E** along *z*
D) **B** along *x*, **E** along *y*
E) None of these

r2

A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y* direction.
Very shortly after t=0, the **E** and **B** fields:



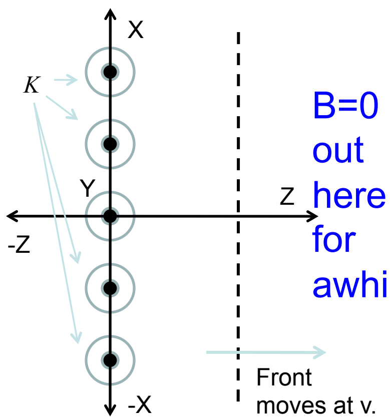
A) Remain zero.
B) Immediately appear with their static values in all space.
C) Appear only near **K**
D) Appear everywhere, but exponentially suppressed as you move farther away from **K.**
E) None of these

r3

A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y* direction.

Shortly afterwards, the **B** field near the sheet:

A) is in the *z*-direction
B) is in the *x*-direction
C) is in the *y*-direction
D) is actually zero close to **K**.
E) None of these



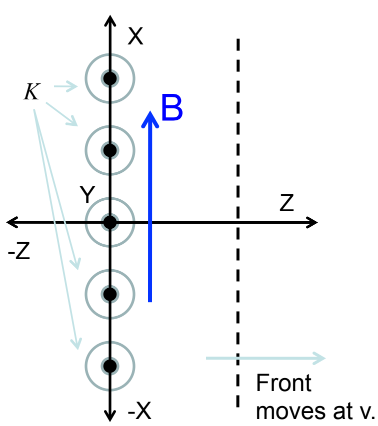
B=0 out here for awhile

r4

A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y*-axis.

Shortly afterwards, the **E** field near the wavefront (but not past it):

A) is in the –*z* direction
B) is in the –*x* direction
C) is in the –*y* direction
D) is actually zero close to *the front*.
E) None of these

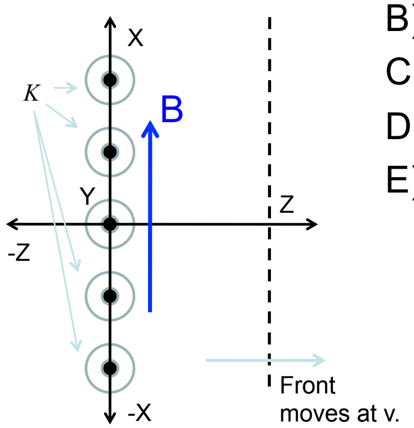


B=0 out here for awhile

r5

A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y* direction.
Shortly afterwards, the **E** field very near the sheet:

A) is in the -*z*-direction
B) is in the -*x*-direction
C) is in the -*y*-direction
D) is actually zero close to **K**.
E) None of these



B=0 out here for awhile

r6

The integrated Poynting flux heading out to infinity is

$$\iint_{\text{large S}} \frac{\vec{E}\times\vec{B}}{\mu_0}\cdot d\vec{a}$$

If the E and B fields are static, with localized sources:
How do E & B fall off with distance?

What does that tell you about the above integral?

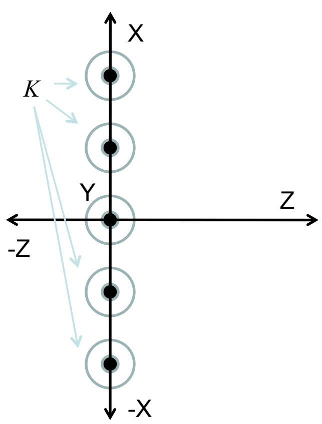
r7

A charge moves in a straight line with constant velocity.
Does it radiate?

A) Yes, and I can defend my answer
B) Yes, but I cannot explain why I believe this
C) No, and I can defend my answer
D) No, but I cannot explain why I believe this
E) It depends on the reference frame of the observer!

r8

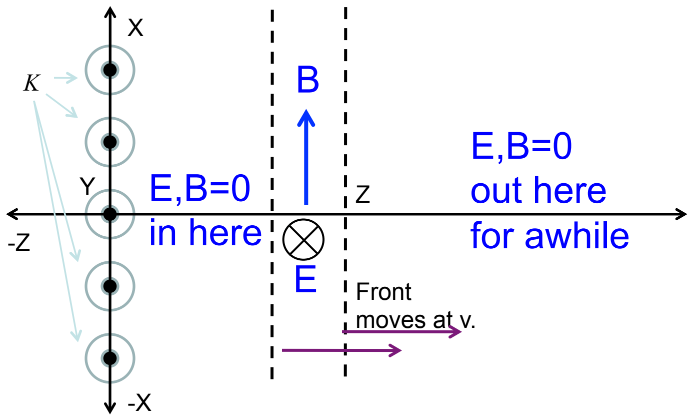
A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y* direction.
It is suddenly turned OFF at $t=t_1$.
Describe E and B everywhere in space!



(No clicker question,
just be ready to voice your ideas!)

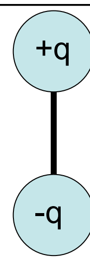
r9

A neutral infinite current sheet, **K**, is turned on at *t*=0, flows in the *x*-*y* plane, in the +*y* direction.
It is suddenly turned OFF at t=0.
Describe E and B everywhere in space!



r10

A small oscillating dipole has height d, and charge q(t) at the ends.
A wire carries the oscillating current back and forth between the two poles.



$=q_0 \cos\omega t$

What is I(t), the current in the wire?

A) $q_0 \cos\omega t$

B) $\dfrac{q_0 \cos\omega t}{d}$

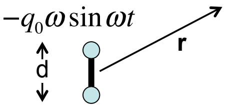
C) $-q_0\,\omega \sin\omega t$

D) $-q_0 d\,\omega \sin\omega t$

E) Something else?!

r11

You are FAR from a small oscillating dipole, $I(t) = -q_0 \omega \sin \omega t$



and you want to compute the vector potential:

$$\vec{A}(\vec{r},t) = \frac{\mu_0}{4\pi} \iiint \frac{\vec{J}(\vec{r}\,',t_R)}{|\vec{r}-\vec{r}\,'|} d^3\vec{r}\,', \text{ with } t_R = t - \frac{|\vec{r}-\vec{r}\,'|}{c}$$

What is the leading order approximate expression for **A**(**r**, t) ?

A) $\frac{\mu_0}{4\pi} \frac{-q_0 \omega \sin \omega t}{r} \hat{z}$

B) $\frac{\mu_0}{4\pi} \frac{-q_0 \omega \sin \omega (t - r/c)}{r} \hat{z}$

C) $\frac{\mu_0}{4\pi} d \frac{-q_0 \omega \sin \omega t}{r} \hat{z}$

D) $\frac{\mu_0}{4\pi} d \frac{-q_0 \omega \sin \omega (t - r/c)}{r} \hat{z}$

E) Something else?!

r12

What is $\hat{z}$, in spherical coordinates?

A) $\cos\theta\, \hat{r}$

B) $\sin\theta\, \hat{r} + \cos\theta\, \hat{\theta}$

C) $\cos\theta\, \hat{r} + \sin\theta\, \hat{\theta}$

D) $\cos\theta\, \hat{r} - \sin\theta\, \hat{\theta}$

E) Something else?!

$$Thus,\ \vec{A}(r,t) = \frac{\mu_0}{4\pi} d \frac{-q_0 \omega \sin \omega (t - r/c)}{r} \left(\cos\theta\, \hat{r} - \sin\theta\, \hat{\theta} \right)$$

$$\vec{B}(r,t) = \nabla \times \vec{A}(r,t) = \frac{-\mu_0 p_0 \omega^2}{4\pi} \sin\theta \frac{\cos \omega (t - r/c)}{rc} \hat{\varphi}$$

r13

For an oscillating dipole, $p=p_0 \cos(\omega t)$,
we worked out last class (assuming $r \gg \lambda \gg d$) that:

$$B(r,t)\,\hat{\varphi} = \frac{-\mu_0 p_0 \omega^2}{4\pi} \sin\theta \frac{\cos\omega(t - r/c)}{rc} \hat{\varphi}$$

To think about (be prepared to discuss): In what ways is it like (and not like) our familiar free-space "traveling plane wave"?

Which of the following describes the E field?

A) $\vec{E} = cB\,\hat{\varphi}$ B) $\vec{E} = cB\,\hat{\theta}$ C) $\vec{E} = cB\,\hat{r}$ D) $\vec{E} = cB\,\hat{z}$

E) None of these/something else?

r14

Total power radiated by a small electric dipole is

$$P = \iint \frac{\mu_0 p_0^2 \omega^4}{(16\pi^2) c r^2} \sin^2\theta \cos^2\omega(t - r/c)\, da$$

$$= \frac{\mu_0 p_0^2 \omega^4}{6\pi c} \cos^2\omega(t - r/c)$$

What is the time averaged power?

What is the time averaged intensity at distance "r"?

r15 The time averaged Poynting vector (far from a small electric dipole) is approximately:

$$\langle \vec{S} \rangle = \frac{\mu_0 p_0^2 \omega^4}{32\pi c r^2} \sin^2\theta \ \hat{r}$$

Describe this energy flow in words, pictures, or graph.

r16

$$R_{rad} \equiv \frac{P_{ave}}{I_{rms}^2}$$

Recall, we found I = $-q_0\omega\cos(\omega t)$.
So what is I_{rms}?

A) $q_0\omega$ B) $q_0\omega/2$ C) $q_0\omega/\sqrt{2}$ D) $\sqrt{2}q_0\omega$
E) None of these/something else?

$$R_{rad} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \frac{2\pi}{3} (d/\lambda)^2$$

r17

We're interested in power radiated by a wiggling charge.

1) What physics variables might this power possibly depend on? (Come up with a complete, but not OVERcomplete list)

2) If your list of variables was v_1, v_2, etc…, we're saying $P = v_1^a v_2^b \ldots$

Look at the SI UNITS of all quantities involved. I claim you should be able to uniquely figure out those powers (a,b, …) ! Try it.

Hint: My list of variables is q, a, c, and μ_o

r18

The TOTAL power of an accelerating (non-relativistic) charge is called **Larmor's formula**.
It depends on c, μ_0, a (acceleration) and q (charge).

So I presume that means $P = c^A \mu_0^B a^C q^D$
(!? It's at least a plausible guess…)

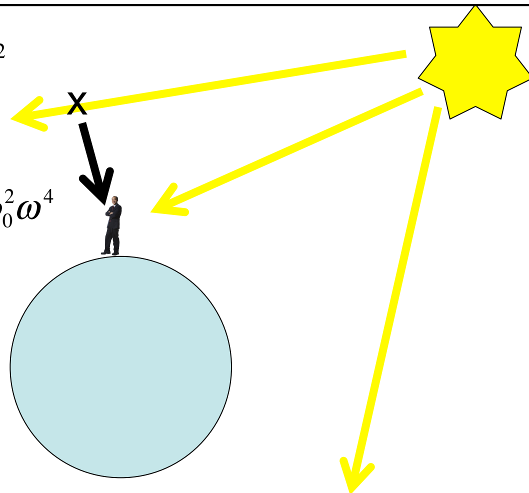
Figure out the *constants* A-D in that formula, without using any physics beyond units! (This is *dimensional analysis)*

Note: $[P]$ = Watts = kg m^2/s^3,
$[\mu_0]$= N/A^2 = kg m/C^2

r19

Larmor: $P_{tot} = \frac{\mu_0}{6\pi c} q^2 a^2$

E-dipoles: $\langle P \rangle = \frac{\mu_0}{12\pi c} p_0^2 \omega^4$



If light scatters from point "x" and heads towards the observer,

What color is it likely to be? Why???

Is the scattered light polarized? If so, which way?

r20

Have you studied the special theory of relativity?

A) Yes, pretty much just in Phys 2170
B) Yes, pretty much just in Phys 2130
C) Yes, in MORE than one class by now.
D) Not in a *class*, but I've read/learned some on my own
E) No, not really